

REMARKS

The Office Action was mailed in the present case on May 7, 2009, making a response due on or before August 7, 2009. This Response is being submitted, along with a Petition for Extension of Time Within the First Month, and the required extension fee of \$130.00 for a large entity. No additional fee is thought to be due at this time. If any additional fee is due for the continued prosecution of this application, please charge the same to Applicant's Deposit Account No. 50-2555 (Whitaker, Chalk, Swindle & Sawyer, LLP).

Applicant filed a Request For Continued Examination on April 27, 2009. In the amendment which accompanied that filing, Applicant had amended independent Claim 1 to call for a:

"Calco-magnesian aqueous suspension having particles of solid matter with a solid matter content greater than or equal to 32% by weight, characterized in that it presents, before being put into suspension, a specific surface area, calculated according to the BET method, which is less than or equal to 10 m²/g."

The Examiner had previously rejected Applicant's Claims 1-6 under 35 U.S.C. §103(a) as being unpatentable over the reference to *Huege et al.* (US 5616283). The Examiner argues that *Huege et al.* discloses a calco-magnesian suspension having particles of solid matter with a solid content of more than 39% by weight and a viscosity of less than 1000 cps (in fact, "less than 2000 cps, preferably less than 1000 cps"). The Examiner also states that *Huege et al.* teaches a particles size that is finer than 20 mesh (which is approximately 841 μm) and is of the opinion that surface area is a function of particle size. This last conclusion leads the Examiner to conclude that the teaching of the reference thus anticipates the express language of Applicant's Claim 1, namely in describing "particles of solid matter with a specific surface area, calculated according to the BET method, which is less than or equal to 10 m²/g.

However, as Applicant has previously argued, even assuming that external specific surface area can be said to be a function of the particle size, it is clear that this is not the case with respect to the internal specific surface area. The external specific surface area is the Blaine specific surface area which is greatly affected by particles size changes and is more indicative of particle size (see the previously referenced U.S. Patent No. 4,829,107, column 1, lines 52-57, as well as column 4, line 31-40).

However, in Claim 1, the claimed feature is a "specific surface area less than or equal to $10 \text{ m}^2/\text{g}$ calculated according to the BET method" (Applicant's emphasis). As will be clear from the remarks which follow, this internal specific area is not dependent on the particle size.

Further, there is no specific surface area calculated according to the BET method disclosed in *Huege et al.* and in addition, no internal specific surface area can be derived from the disclosure of *Huege et al.* It is therefore clear that Claim 1 is not obvious over *Huege et al.* since this document only discloses that it is preferable to have a lime slurry with a very fine particle size to maintain the desired reactivity and to use a dispersing aid (alkali metal hydroxide) to further lower the viscosity of the slurry after the dispersing agent and the lime have been mixed, (see column 3, lines 50 to 55 and 57 to 67).

Huege et al. hence uses two additives to keep a low viscosity and also clearly does not disclose that with an internal specific surface area of less than or equal to $10 \text{ m}^2/\text{g}$, without strictly requiring the use of a dispersant, a solid content greater than 32% by weight is obtained.

Further, as already mentioned, *Huege et al.* teaches the use of a particle size as fine as possible. A particle size as fine as possible will yield to an increased external specific surface area and therefore to an increased viscosity.

The taught particle size in *Huege et al.* is under 20 mesh (841 μm). The invention of the Applicant uses a d_{98} of less than 20 μm which is about 42 times less. Therefore it would appear that the viscosity of a lime slurry prepared according to the teaching of Applicant's invention would lead to a viscosity which is drastically increased, since the particle size is strongly reduced. However, in actual practice, exactly the opposite effect is reached by following the teaching of the invention, because the internal specific surface area as claimed is radically different from the external specific surface area according to *Huege et al.*

Applicant is attaching to these Remarks the Declaration of Professor Jean-Paul Pirard, Professor of Chemical Engineering at Liege University, Belgium. Professor Pirard's Resume follows the Declaration. As will be apparent from reading the Declaration of one skilled in the art, and in fact expert in the art of surface area measurements, specific surface area measurements made by the Blaine method referenced in the Huege patent differ greatly from measurements made by the BET method. More particularly, the BET specific surface area is either equal to or higher than the Blaine specific surface area. It will be equal if the particles of the material are strictly non porous, which is not the case with the particles being considered in the present invention. As soon as the particles are slightly porous, the internal surface area of the material becomes important in comparison to the external surface area and consequently, the BET specific surface area is, in general, much larger than the Blaine specific surface area. The accompanying Declaration includes numerical examples of the magnitude of these differences.

Professor Pirard's conclusion is that "the BET specific surface area, S_{BET} , and the Blaine specific surface area, S_p , are two different characteristics of a porous material almost independent of each other. They cannot be taken for one another."

In the last Office Action, the Examiner argues that Applicant's claims "as written do not explicitly recite an internal surface area" and thus the reference still reads on the claims and further that Huege et al. would "broadly encompass the claimed range." Applicant would submit that the claim language

"as measured according to the BET method" should, in and of itself, make a clear distinction in this regard when read in light of the attached Declaration. However, to remove any doubt on this point, Applicant has amended each of independent Claims 1 and 7 to explicitly recite "having particles with a specific surface area, calculated according to the BET method, taking into account internal specific surface area." This language emphasizes the difference between the Blaine method and the BET method, in which the first is related to the external specific surface area, and in which the BET method is related to both the external specific surface area and the internal specific surface area, the internal specific surface area becoming the main specific surface area in the case of porous particles of the type under consideration.

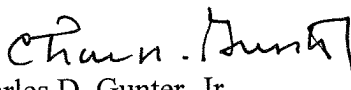
Further, from Table 2 of the Declaration, it can be seen that the BET surface area can be comparable for several different Blaine specific surface areas while, on the contrary that the Blaine specific surface area can be comparable for very different BET specific surface areas. For this reason, it can be seen that the two types of specific surface area are not related one to each other and hence, the BET specific surface area is clearly not linked to particle size as soon as a porous material is involved (as is the case in the present invention).

The attached Declaration also includes comparative data comparing the Huege et al. lime products with products made according to the teachings of the present invention, with a low BET specific surface area. Accordingly, the differences in the teaching of the Huege et al. should be readily apparent.

Based upon the above arguments and amendments, the remaining claims are now thought to be allowable over the art of record, and an early notification of the same would be appreciated.

Respectfully submitted,

Date: September 4, 2009



Charles D. Gunter, Jr.

Reg. No. 29,386

Whitaker, Chalk, Swindle & Sawyer, LLP

301 Commerce St, Suite 3500

Fort Worth, Texas 76102

(817) 878-0504

ATTORNEY(S) FOR APPLICANT

Specific surface area

The specific surface area of a solid material is its surface area by unit of mass. If the mass of a solid is unique, however its surface area is function of the measurement method used. This note aims to compare the signification of the specific surface area determined by the permeability method (Blaine method) and the one determined by the nitrogen adsorption-desorption method (Brunauer-Emmet-Teller method or BET method).

1. Blaine method

As far as steady-state permeability in packed powder beds is concerned, any pore space which is located “within” (as distinct from “between”) the particles is of little importance. The external specific surface area, treated here, merely embraces the outer boundary surface area of the solid powder, disregarding its intrinsic porosity. Thus the specific surface area determined with the permeability method represents only the external part of the total specific surface area. The total specific surface area, which takes into account the intrinsic porosity of the solid, is preferably determined by vapour adsorption methods. For the evaluation of catalysts, the entire surface area involved in a reaction is of interest. In mineral processing, the external specific surface area is generally used as a means to characterize the degree of crushing of a material.

The basic law governing permeability calculations is the Darcy law (1856), which states that the flow rate is proportional to the pressure gradient causing the flow. Kozeny (1927) derived a correlation between permeability, powder bed porosity and particle surface area. This equation was adopted by Carman (1937) for the determination of the specific surface area of powder materials. The specific surface area can be calculated from the permeability, i.e. the time a certain quantity of the permeating fluid needs to flow through a defined powder bed.

Evaluation of the specific surface area can be carried out with the Kozeny-Carman equation for granular beds :

$$S_p = \frac{7d}{Q(1-\varepsilon)} \left(\frac{\varepsilon^3 \pi \Delta P}{l \mu Q} \right)^{1/2} \quad [1]$$

where

S_p = specific surface area according to the permeability method (m^2/kg)

Q = particle density (kg/m^3)

ε = porosity of the powder bed (-)

d = bed diameter (m)

ΔP = pressure drop across the bed (Pa)

l = bed length (m)

μ = dynamic viscosity of the permeating medium (Pa.s)

Q = flowrate (m^3/s)

The Kozeny-Carman equation [1] which is the basis of the permeability method can be applied to the Blaine technique in the following form :

$$S_p = \frac{C}{Q(1-\varepsilon)} \left(\frac{\varepsilon^3 t}{\mu} \right)^{1/2} \quad [2]$$

where

3/7
Purd

C = apparatus constant

t = running time between two marks on the U-tube manometer

Because in the Blaine technique, the gas volume introduced in the apparatus is constant and the pressure variation is constant, as a consequence the time required to observed the pressure variation is a measure of the permeability and, thus, of the external specific surface area.

The important point is that the porosity ε is the powder bed porosity and not the intrinsic porosity of the particles constituting the powder bed. As a consequence, the specific surface area determined by the Blaine method concerns the external surface area of the particles.

2. BET method

The BET method, proposed by Brunauer, Emmet and Teller (1938), is based on the following assumptions:

- 1° the adsorption is localized on well-defined sites, each of them admitting strictly one adsorbed molecule; each site is showing the same energy (homogeneous surface) and the adsorbed molecules do not interact with each other;
- 2° from the beginning, the adsorption is carried out in several layers, molecules adsorbed in the first layer being adsorption sites for the molecules of the second layer, and so on;
- 3° there is a permanent equilibrium between the amount of molecules being adsorbed at the surface of the material and the amount of molecules being desorbed from the surface. Desorption is an activated process which activation energy is E_1 for the first adsorbed layer and E_L for the next layers. E_1 is the heat of adsorption of the molecule at the solid surface and E_L is the latent heat of liquefaction of the steam at the considered temperature.

The mathematical treatment of those assumptions leads to the equation of the adsorption isotherm, known under the name of BET equation. This equation allows the determination of the vapour volume, v_m , necessary to cover totally the solid surface area with a monomolecular layer of adsorbate. For nitrogen at a temperature of 77 K, v_m is directly linked to the BET specific surface area, S_{BET} , by the relation:

4/7 *Paul*

$$S_{\text{BET}} = 4.37 v_m \quad [3]$$

The important point is that nitrogen molecules are adsorbed on the whole accessible surface of the material. As a consequence, the specific surface area determined by the BET method concerns the total surface area of the particles, i.e. the external surface area and the internal surface area, the latter being linked to the intrinsic porosity.

As a conclusion, the BET specific surface area is either equal or higher than the Blaine specific surface area. It will be equal if the particles of the material are strictly non porous. As soon as the particles are slightly porous, the internal surface area of the material becomes important in comparison to the external surface area and, as a consequence, the BET specific surface area is, in general, larger or much larger than the Blaine specific surface area. This conclusion will be highlighted by some examples.

3. Examples

Example 1 : Theoretical calculation of the external geometric surface area of a spherical particle of a material.

$$S_{\text{ext}} = \frac{6}{d\rho} \quad [4]$$

where

d = particle diameter (m)

ρ = particle density (kg/m^3) = 400 kg/m^3 for standard hydrated lime.

Table 1 : Calculation of the external geometric surface area of a spherical particle of hydrated lime as a function of the particles diameter.

5/7 *Paul*

Particle diameter (m)	S_{ext} (m ² /kg)	S_{ext} (m ² /g)
10^{-3} (1 mm)	15	0.015
10^{-4} (100 μm)	150	0.15
5×10^{-5} (50 μm)	300	0.3
3×10^{-5} (30 μm)	500	0.5
10^{-5} (10 μm)	1500	1.5
3×10^{-6} (3 μm)	5000	5
1.5×10^{-6} (1.5 μm)	10000	10
3.7×10^{-7} (0.37 μm)	40000	40

Example 2 : Comparison between the Blaine specific surface area and the BET specific surface area measured on 3 samples.

Three samples of hydrated lime were characterised. Sample A is an hydrated lime with a low BET specific surface area, S_{BET} , sample B is a standard hydrated lime of current industrial production and sample C is an hydrated lime with high BET specific surface area, S_{BET} . Samples A and B were sieved at 32 μm (± 425 mesh) in order to highlight the influence of the particle sizes on the specific surface area. The powder retained at 32 μm for sample A is noted $A > 32 \mu\text{m}$; the powder passing through is noted $A < 32 \mu\text{m}$. Table 2 summarises the values determined at the laboratory for the Blaine specific surface area, S_p , and for the BET specific surface area, S_{BET} .

Table 2 : Blaine specific surface area, S_p , and specific surface area BET, S_{BET} , of samples A, B and C.

	S_p (m ² /g)	S_{BET} (m ² /g)
A	1.1	5.4
$A > 32 \mu\text{m}$	0.3	5.2
$A < 32 \mu\text{m}$	1.2	5.6
B	1.3	10.6
$B < 32 \mu\text{m}$	1.6	9.7
C	1.4	38.8

4. Discussion

At Table 2, it can be seen that the BET specific surface area, S_{BET} , is systematically at least 5 times larger than the Blaine specific surface area, S_p . Furthermore, the BET specific surface area, S_{BET} , for a given hydrated lime is independent of the particles size, while the Blaine specific surface area, S_p , is dependent of the particle size. In particular, the Blaine specific surface area, S_p , of the sample A cut with particles size larger than $32\ \mu\text{m}$ ($0.3\ \text{m}^2/\text{g}$) is much lower than the Blaine specific surface area, S_p , of the not sieved sample A ($1.1\ \text{m}^2/\text{g}$). Conversely, the Blaine specific surface area, S_p , of the samples cut with particles size lower than $32\ \mu\text{m}$ is always larger than the Blaine specific surface area, S_p , of the corresponding samples being not sieved. Indeed, at Table 1, it can be observed that the lower the particle size, the larger the geometric external specific surface, corresponding to the Blaine specific surface area.

Table 2 also shows that, for the three samples A, B and C being not sieved, the value of the Blaine specific surface area, S_p , is very close to one another, while the value of the BET specific surface area, S_{BET} , may vary with a factor 7, the lowest value being $5.4\ \text{m}^2/\text{g}$ for sample A and the highest value being $38.8\ \text{m}^2/\text{g}$ for sample C. This observation means that the BET specific surface area, S_{BET} , depends in the first degree of factors different than the particle size.

Table 1 and Table 2 also show that the Blaine specific surface area, S_p , ($0.3\ \text{m}^2/\text{g}$) of the sample A cut with particle size larger than $32\ \mu\text{m}$ ($A > 32\ \mu\text{m}$) is lower than the geometric external specific surface ($0.5\ \text{m}^2/\text{g}$) calculated for a particle diameter of $30\ \mu\text{m}$, S_{ext} . This result is not surprising because the average size of particles of sample cuts with particles size larger than $32\ \mu\text{m}$ is necessarily above $30\ \mu\text{m}$. The value of Blaine specific surface area of $0.3\ \text{m}^2/\text{g}$ corresponds to particle diameter of $50\ \mu\text{m}$ in Table 1. On the contrary, the Blaine specific surface area, S_p , ($1.2\ \text{m}^2/\text{g}$ et $1.6\ \text{m}^2/\text{g}$), of sample cuts with particle size lower than $32\ \mu\text{m}$ is larger than the geometric external specific surface calculated for a particle diameter equal to $30\ \mu\text{m}$, S_{ext} ($0.5\ \text{m}^2/\text{g}$). The values of the Blaine specific surface area, S_p , ($1.3\ \text{m}^2/\text{g}$ et $1.6\ \text{m}^2/\text{g}$) are corresponding to a particle diameter equal to $10\ \mu\text{m}$, S_{ext} ($1.5\ \text{m}^2/\text{g}$).

7/7
Pirard

Finally, at Table 1 and Table 2, it can be observed that if the BET specific surface area, S_{BET} , would have corresponded to a geometric external specific surface, S_{ext} , the particle size would vary from 3 μm to 0.37 μm which is quite below the usual particle sizes measured for those materials.

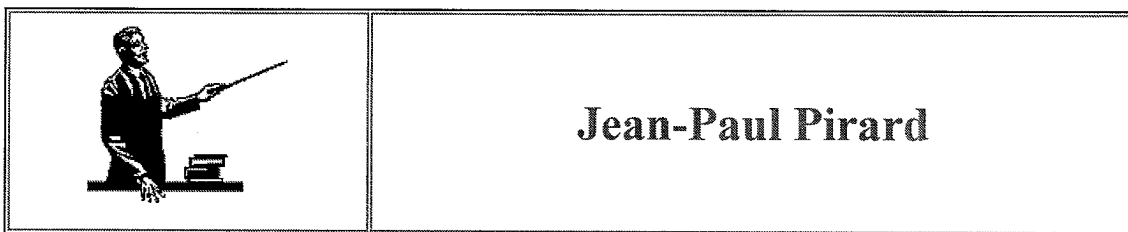
In conclusion, the BET specific surface area, S_{BET} , and the Blaine specific surface area, S_p , are two different characteristics of a porous material almost independent of each other. They can not be taken for one another.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.


Signature

August, 31, 2009
Date

Jean-Paul PIRARD



Birth date: November 16th 1947

Nationality: Belgian

QUALIFICATIONS:

- Chemical Engineer Civil, Liege University, 1970.
- Ph. D. in Applied Science, Liege University, 1974.

POSITIONS:

- Professor of Chemical Engineering at Liege University.

TEACHING DUTIES:

- Reaction kinetics
- Coal gasification processes
- Catalysis (Mass and heat transfers, porous texture ...)

TECHNICAL EXPERIENCE:

1970-1975	FNRS fellowship
1975-1981	Assistant Professor of Chemical Engineering, Liège University
1981-1991	Associate Professor, University Liege
1992 --	Full Professor of Chemical Engineering, Liège University

RESEARCH INTERESTS:

- Catalysis.
- Chemical Reactor Engineering.
- Sol-gel process.
- Underground coal gasification
- Porous materials
- Carbon nanotubes

LAST PUBLICATIONS:

Methods for the preparation of bimetallic Xerogel catalysts designed for chlorinated wastes processing,

Lambert S, Ferauche F, Heinrichs B, Cherkasova N, Pirard JP, Alie C
Journal of Non-Crystalline Solids, **352 (26-27)**, 2751-2762 (2006).

Multigram Scale Synthesis and Characterization of Low-Density Silica Xerogels,

Alie, C., Cherkasova, N. Ferauche, F., Lambert, S., Heinrichs, B., Pirard, R. Pirard, J.-P.,
Journal of Non-Crystalline Solids, **352 (26-27)**, 2763-2771 (2006).

A TEM study on the localization of metal particles in cogelled Xerogel catalysts,

Heinrichs, B., Geus, JW, Lambert, S., Pirard, J.-P.,
Journal of Catalysis, **241** (1), 229-231 (2006).

Carbon materials as catalyst Xerogels: Study of mass transfer,

Job, N., Heinrichs, B., Lambert, S., Pirard, J.-P., Colomer, J.-F., Vertruyen, B., Marien, J.,
AIChE Journal, **52** (8), 2663-2676 (2006).

Non-intrusive mercury porosimetry: Pyrolysis of resorcinol-formaldehyde Xerogels,

Job, N., Pirard, R. Pirard, J.-P., Alie, C.,
Particle & Particle Systems Characterization, **23** (1), 72-81 (2006).

The nonlinear optical, magnetic, and Mossbauer spectral properties of some iron (III) doped silica Xerogels,

Rebbouh, L., Rosso, V., Renotte, Y., Lion, Y., Grandjean, F., Heinrichs, B., Pirard, J.-P., Delwiche J, Hubin-Franskin, M. -- J., Long, GJ,
Journal of Materials Science, **41** (10), 2839-2849 (2006).

Highly dispersed platinum catalysts prepared by impregnation of texture-tailored carbon Xerogels,

Job, N., Pereira, MFR, Lambert, S., Cabiach, A., Delahay, G., Colomer, JF, Marien, J., Figueiredo, JL, Pirard, J.-P.,
Journal of Catalysis, **240** (2), 160-171 (2006).

Structure of Silica Xerogels organoalkoxysilane synthesized with co-reactants hints at multiple phase separation,

Gum, JR, Basiura, M., Goderis B, Pirard JP, Blacher, S.,
Journal of Physical Chemistry B, **110** (15), 7757-7765 (2006).

Pd-Ag/SiO₂ Xerogel catalyst forming by impregnation on alumina foams,


Alie, C., Ferauche, F., Leonard, A., Lambert, S., Cherkasova, N., Heinrichs, B., Crine, M., Marchot, P., Lukin, E., Pirard, J. -- P.,
Chemical Engineering Journal, 117, 13-22, 2006.

Rheological determination of sol-gel transition during the aqueous synthesis of resorcinol-formaldehyde resins,

Job N, Panariello, F., Pirard, J.-P., Crine, M., Leonard, A.,
Colloids and Surfaces A: Physicochemical and Engineering Aspects (in press)

Towards the production of carbon Xerogel monoliths by optimizing convective drying conditions,

Job, N., Sabatier, F., Pirard, J.-P., Crine, M., Leonard, A.,
Carbon, 44 (12), 2534-2542, 2006.

Synthesis optimization of organic Xerogels produced from convective air-drying of resorcinol-formaldehyde gels, 

Job, N., Panariello, F., Marien, J., Crine, M., Pirard, J.-P., Léonard, A.,
Journal of Non-Crystalline Solids, 352 (1), 24-34, 2006.

Study of the connectivity properties of Bioglass (R)-filled polylactide foam scaffolds by image analysis and impedance spectroscopy,

Blacher, S., Maquet, V. Jerome, R., Pirard, J.-P., Boccaccini, AR
Biomaterialia Acta, 1 (5): 565-574 (2005).

Assessment of the 3D localization of metallic nanoparticles in Pd/SiO₂ cogelled catalysts by electron tomography,

Gum, JR, de Jong K, Pirard JP, Blacher, S.,
Langmuir, 21 (26), 12378-12385 2005).

Formation and structural characteristics of Pd-Ag/SiO₂ and Pd-Cu/SiO₂ Catalysts Synthesized by Cogels,

Lambert, SD, gums, C. Alie, C., Cherkasova, N., Pirard, J.-P., Heinrichs, B.,
Journal of Non-Crystalline Solids, 351 (52-54), 3839-3853 (2005).

Phase separation during silica gel formation followed by time-resolved SAXS,

Gum, JR, Blacher S, Goderis B, Pirard, J.-P.,
Nuclear Instruments & Methods in Physics Research Section B, Beam Interactions with Materials and Atoms, 238 (1-4), 141-145 (2005).

Carbon aerogels, cryogels and Xerogels: Influence of the drying method on the textural properties of porous carbon materials,

Job, N., Thery, A., Pirard, R., Marien, J., Kocon, L., Rouzaud, JN, Beguin, F., Pirard, J.-P.
Carbon, 43 (12), 2481-2494 (2005).

Hydrodechlorination of 1,2-dichloroethane on Pd-Ag catalysts supported on tailored texture carbon Xerogels,

Job, N., Heinrichs, B., Ferauche, F., Noville, F., Marien J, Pirard, J.-P.,
Catalysis Today, 102, 234-241 (2005).

Pd-Ag/SiO₂ and Pd-Cu/SiO₂ cogelled Xerogel catalysts for selective hydrodechlorination of 1,2-dichloroethane into ethylene,

Lambert, S., Ferauche, F. Brasseur, A., Pirard, J.-P., Heinrichs, B.,
Catalysis Today, 100 (3-4), 283-289 (2005).

Olefin cyclopropanation and insertion into OH bonds mediated by copper (I) and palladium (II) covalently anchored to silica Xerogels,

Sacco, L., Lambert, S., Pirard, J.-P., Noels, AF,
Journal of Catalysis, 232 (1), 51-59 (2005).

Nitrogen Adsorption on Silica Xerogels or the odd look of any plot,

Gum, JR, Blacher, S., Pirard, J.-P.,

Langmuir, **21** (5), 1703-1705 (2005).

Microporous and heterogeneous surface adsorption isotherms Arising from Levy distributions

Brouers, F., Sotolongo, O., Marquez, F., Pirard, J.-P. ,
Physica A-Statistical Mechanics and its Applications, **349** (1-2), 271-282 (2005).

Synthesis of finely dispersed metal catalysts supported on highly porous oxides in one single step by Cogels,

Heinrichs, B., Lambert, S., Pirard, J.-P.,
A bstract of papers of the American Chemical Society, **227**, 816, 082-COLL Part 1 (2004).

Convective drying of wastewater sludges: Influence of air temperature, superficial velocity and humidity on the kinetics,

Leonard A, Blacher, S., Marchot, P., Pirard, J.-P., and Crine M.,
Drying Technology, **23** (8), 1667-1679 (2005).

Moisture profiles determination during convective drying using X-ray microtomography,

Leonard, A., Blacher, S., Marchot, P., Pirard, J.-P., Crine, M.,
Canadian Journal of Chemical Engineering, **83** (1), 127-131 (2005).

Suitability of convective air drying for the production of porous resorcinol-formaldehyde and carbon Xerogels,

Leonard, A., Job, Blacher S, Pirard, J.-P., Crine, M., Jomaa, W.,
Carbon, **43** (8), 1808-1811 (2005).

Image analysis of X-ray microtomograms of Pd-Ag/SiO₂ Xerogel catalysts supported on Al₂O₃ foams,

Blacher, S., Leonard, A., Heinrichs, B., Cherkasova, N. Ferauche, F., Crine, M., Marchot, P., Lukin, E., and Pirard, J.-P.,
Colloids and Surfaces A: Physicochemical and Engineering Aspects, **241** (1-3), 201-206 (2004).

Preparation and Characterization of Xerogel catalyst microspheres,

Alie, C., Ferauche, F., Heinrichs, B., Pirard, R., Winterton, N., Pirard, J.-P.,

Journal of Non-Crystalline Solids, 350, 290-298 (2004).

Synthesis of transition metal-doped carbon Xerogels by solubilization of metal salts in resorcinol-formaldehyde aqueous solution

Job, N., Pirard R, Marien J, Pirard, J.-P.,
Carbon, **42** (15), 3217-3227 (2004).

Synthesis of SiO₂ Xerogels and Pd/SiO₂ cogelled Xerogel catalysts from silylated acetylacetonate ligand

Lambert, S., Sacco, L., Ferauche, F., Heinrichs, B., Noels, A., Pirard, J.-P.,
Journal of Non-Crystalline Solids, **343** (1-3), 109-120 (2004).

Study of textural properties and nucleation phenomenon in Pd/SiO₂, Ag/SiO₂ and Cu/SiO₂ cogelled Xerogel catalysts,
Lambert, S. Alie, C., Pirard, J.-P., Heinrichs, B.,
Journal of Non-Crystalline Solids, **342** (1-3), 70-81 (2004).

Elaboration of new formulations to remove micropollutants in Mswia flue gas,
Brasseur, A. Gambin, A., Laudet, A., Marien J, Pirard, J.-P.,
Chemosphere, **56** (8), 745-756 (2004).

Alignment of glial cells stimulates directional neurite growth of CNS neurons in vitro
Deumens R, Koopmans GC, Den Bakker, CGJ, Maquet, V., Blacher, S., Honig, WMM, Jerome, R., Pirard, J.-P., Steinbusch, HWM, Joosten EAJ,
Neuroscience 125, 591-604 (2004).

Comparison of different methods for characterizing multi-walled carbon nanotubes,
Gum, C., Blacher, S., Dupont-Pavlovsky, N., Bossuot, C., Lamy, M., Brasseur, A., churchwardens, D., Fonseca, A., McRae, E., Nagy JB, Pirard, J.-P.,
Colloids and Surfaces A: Physicochemical and Engineering Aspects, **241** (1-3), 155-164 (2004).

Influence of the operating conditions on the production rate of multi-walled carbon nanotubes in a CVD reactor,
Gum, C., Blacher, S., Bossuot, Ch Marchot, P., Nagy, JB, Pirard, J.-P.,
Carbon, **42** (8-9), 1473-1482 (2004).

Porous carbon Xerogels with texture tailored by pH control during sol-gel process,
Job, N., Pirard R, Marien J, Pirard, J.-P.,
Carbon, **42** (3), 619-628 (2004).

Determination of surface composition of alloy nanoparticles and relationships with catalytic activity in Pd-Cu/SiO₂ cogelled Xerogel catalysts,
Lambert, S., Heinrichs, B., Brasseur, A. Rulmont A., Pirard, J.-P.,
Applied Catalysis A: General, **270** (1-2), 201-208 (2004).

Improvement of metal dispersion in Pd/SiO₂ cogelled Xerogel Catalysts for 1,2-dichloroethane hydrodechlorination,
Lambert, S., Polard, J.-F., Pirard, J.-P., Heinrichs, B.,
Applied Catalysis B: Environmental, **50** (2), 127-140 (2004).

Synthesis of Pd/SiO₂, Ag/SiO₂, and Cu/SiO₂ cogelled Xerogel catalysts: study of metal dispersion and catalytic activity,
Lambert, S., Cellier, C., Grange, P., Pirard, J.-P., Heinrichs, B.,
Journal of Catalysis, **221** (2), 335-346 (2004).

Application of X-ray microtomography to follow cracks development during convective drying of deformable materials,

Leonard, A., Blacher, S., Marchot, P., Pirard, J.-P., Crine, M.,

Chem. Eng. Technol. (Electronic Version),

[http://www.dechema.de/granada/TOPIC% 20 -% 2008/T8.4/P-8.4-013.pdf](http://www.dechema.de/granada/TOPIC%20-%202008/T8.4/P-8.4-013.pdf),
(2004).

Measurement of shrinkage and cracks associated to convective drying of soft materials by X-ray microtomography,

Leonard, A., Blacher, S., Marchot, P., Pirard, J.-P., Crine, M.,

Drying Technology (in press).

Moisture profiles determination during convective drying using X-ray microtomography,

Leonard, A., Blacher, S., Marchot, P., Pirard, J.-P., Crine, M.,

Accepted for publication in the *Canadian Journal of Chemical Engineering*.

Ball milling effect on the structure of single-wall carbon nanotubes,

Pierard, N., Fonseca, A., Colomer, J.-F., Bossuot, C., Benoit, JM, Van

Tendeloo, G., Pirard, JP, Nagy JB,

Carbon, **42** (8-9), 1691-1697 (2004).

Preparation of Low-Density Xerogels from mixtures of TEOS with substituted alkoxysilanes. I. 17O NMR study of the hydrolysis-condensation process,

Alie, C., Pirard, J.-P.,

Journal of Non-Crystalline Solids, **320** (1-3), 21-30 (2003).

Preparation of Low-Density Xerogels from mixtures of TEOS with substituted alkoxysilanes. II. Study of the viscosity sol-gel transition

Alie, C., Pirard, R. Pirard, J.-P.,

Journal of Non-Crystalline Solids, **320** (1-3), 31-39 (2003).

Nucleation Phenomenon in Silica Xerogels and Pd/SiO₂, Ag/SiO₂, Cu/SiO₂ catalysts,

Alie, C., Lambert, S., Heinrichs, B., Pirard, R. Pirard, J.-P.,

Journal of Sol-Gel Science and Technology, **26**, 827-830 (2003).

Image analysis of the axonal ingrowth into poly (,-lactide) porous scaffolds in relation to the 3-D porous structure,

Blacher S, Maquet V, Schils F, Martin D, Schoenen J, Moonen G, Jerome R., and Pirard, J.-P.,

Biomaterials, **24** (6), 1033-1040 (2003).

Image analysis characterization of multi-walled carbon nanotubes,

Gum, C., Blacher, S., Masenelli-Varlot, K. Bossout, C., McRae, E.,

Fonseca, A., Nagy, JB, Pirard J.-P.

Carbon, **44/13**, 2561-2572 (2003).

Palladium-silver sol-gel catalysts for selective hydrodechlorination of 1,2-dichloroethane into ethylene: IV. Deactivation mechanism and regeneration,

Heinrichs, B., Noville, F., Schoebrechts, JP., Pirard, J.-P.,
Journal of Catalysis, **220** (1), 215-225 (2003).

Synthesis of Pd/SiO₂, Ag/SiO₂, and Cu/SiO₂ cogelled Xerogel catalysts: study of metal dispersion and catalytic activity,

Lambert, S., Cellier, C., Grange, P., Pirard, J.-P., Heinrichs, B.,
Journal of Catalysis (In Press) (2003).

Application of X-ray microtomography to follow cracks development during convective drying of deformable materials,

Leonard A, Blacher, S., Marchot, P., Pirard, J.-P., and Crine M.,
Proceedings of the 4th European Congress of Chemical Engineering - ECCE4, Granada, Spain, September 21-25, 2003 (2003).

Convective drying of wastewater sludges: Influence of air temperature, superficial velocity and humidity on the kinetics,

Leonard A, Blacher, S., Marchot, P., Pirard, J.-P., and Crine M.,
Proceedings of the X Polish Drying Symposium, Lodz, Poland, September 17-19, 2003 (2003).

Moisture profiles determination during convective drying using X-ray microtomography,

Leonard A, Blacher, S., Marchot, P., Pirard, J.-P., and Crine M.,
Proceedings of the 3rd World Congress on Industrial Process Tomography, Banff, Canada, September 2-5, 2003 (2003).

Image analysis of X-ray microtomograms of soft materials during convective drying,

Leonard, A., Blacher, S., Marchot, P., Pirard, JP, and Crine, M.,
Journal of Microscopy, **212** (2), 197-204 (2003).

Multiscale texture characterization of wastewater sludges dried in a convective rig,

Leonard A, Blacher, S., Marchot, P., Pirard, J.-P., and Crine M.,
Drying Technology, **21** (8), 1509-1258 (2003).

Use of X-ray microtomography To determine internal moisture profiles during convective drying of deformable materials,

Leonard A, Blacher, S., Marchot, P., Pirard, J.-P., and Crine M.,
Proceedings of the European Drying Symposium - EuDrying03, Heraklion, Crete, Greece, September 4-5, 2003 (2003).

Preparation of macroporous biodegradable poly (α-hydroxy acids) and characterization by mercury intrusion porosimetry, image analysis and impedance spectroscopy,

Maquet, V., Blacher S, Pirard R, Pirard, J.-P., Vyakarnam, MN, and Jerome R.

Journal of Biomedical Materials Research, **66A** (2), 199-213 (2003).

Hyperporous characterization of polyurethane-based gels by non-intrusive mercury porosimetry,

Pirard, R., Rigacci, A., Marshall, JC, Quenard, D., Knight, B., Achard P., Pirard, J.-P.,

Polymer, **44** (17), 4881-4887 (2003).

The role of the main silica precursor and the additive in the preparation of low-density Xerogels,

Alie, C., Pirard, R. Pirard, J.-P.,

Journal of Non-Crystalline Solids, **311**, 520-529 (2002).

Image analysis characterization of highly oriented freeze-drying porous materials,

Blacher, S., Maquet, V. Jerome, R., and Pirard, J.-P.,

Image Analysis and Stereology, **21**, 43-48 (2002).

Texture Characterization of ultramacroporous foams using non-destructive methods,

Blacher S, Maquet, V., Leonard, A., Chapelle, G., Crine, M., Jerome, R., and Pirard, JP

Abstracts of the 6th International Symposium on the Characterization of Porous Solids, Alicante, Spain, May 8-11, Communication P38 (2002).

Texture characterization of ultramacroporous materials using non-destructive methods,

Blacher S, Maquet, V., Leonard, A., Chapelle, G., Crine, M., Jerome, R., and Pirard, JP

In: *Characterizations of Porous Solids VI*, Studies of in Surface Science and Catalysis 144 Rogriguez-Reinoso F, McEnaney, B., Rouquerol, J., and Unger, K. (eds), Elsevier Science BV, 331-338 (2002).

Image Analysis and N₂ adsorption-desorption characterization of low density silica Xerogels in presence of additives,

Blacher, S. Alie, C., Lodewijck, L., Pirard, R. Pirard, J.-P.,

Abstracts of the 6th International Symposium on the Characterization of Porous Solids, Alicante, Spain, May 8-11, Communication P37 (2002).

Carbon stable isotope analysis as a tool for tracing the temperature during El Tremedal underground coal gasification at great depth,

Brasseur, A, Antenucci, D, Bouquegneau, JM, Coëme, A., Dauby, P., Létolle, R. Mostade, M., Pirlot, P., Pirard, JP,

Fuel, **81**, 109-117 (2002).

New silica based polymeric systems designed for the solid-liquid extraction of uranyl ions,

Capra, F., Leroy, D., Martinot, L., Lambert, S., Pirard, J.-P., Guillaume, J., Jerome, C. Jerome, R.

Journal of Materials Chemistry, **12**, 137-142 (2002).

Ag/SiO₂ and Cu/SiO₂ cogelled Xerogel combustion catalysts for benzene and 2-butanol dehydrogenation,
Lambert, S., Cherkasova, N., Cellier, C., Ferauche, F., Heinrichs, B., Grange, P., Pirard, J.-P.,
Proceedings of CHISA 2002, 15th International Congress of Chemical and Process Engineering, Praha, Czech Republic, August 25-29, 2002, (CD ROM) (2002).

Is it possible to Obtain a coherent image of the texture of a porous material?,
Noville, F., Gommès, C., Doneux, C., Brasseur, A., Pirard, R., Pirard, J.-P.
Abstracts of the 6th International Symposium on the Characterization of Porous Solids, Alicante, Spain, May 8-11, Communication D55 (2002).

Formatting carbon nanotubes for hydrogen storage,
Pierard, N., Fonseca, A., Tondeur, C. Bossuot, C., Pirard, JP, Nagy JB,
Acts of Congress "Materials 2002", Tours, France, October 21-25 (2002).

Characterization of porous texture of hyperporous materials by mercury porosimetry using densification equation,
Pirard, R., Alie, C., Pirard, J.-P.,
Powder Technology, **128**, 242-247 (2002).

Synthesis of Silica Xerogels with tailored structure
Alie, C., Ferauche, F., Pirard, R., Lecloux, AJ, Pirard, J.-P.
Abstracts of the Second International Conference on Silica Science and Technology, Silica 2001, Mulhouse, France, September 3-6, p.147 (2001).

The use of additives to prepare low-density Xerogels,
Alie, C., Pirard, R., Lecloux, AJ, Pirard, J.-P.
Journal of Non-Crystalline Solids, **285**, 135-141 (2001).

Preparation of Low-Density Xerogels by incorporation of additives during synthesis,
Alie, C., Ferauche, F., Pirard, R., Lecloux, AJ, Pirard, J.-P.
Journal of Non-Crystalline Solids, **289**, 88-96 (2001).

Mercury porosimetry: applicability of the buckling-intrusion mechanism to low-density Xerogels,
Alie, C., Pirard, R. Pirard, JP,
Journal of Non-Crystalline Solids, **292**, 138-149 (2001).

Mercury porosimetry applied to porous silica materials,
Alie, C., Pirard, R. Pirard, JP,
Colloids and Surfaces A: Physicochemical and Engineering Aspects, **187-188**, 365-374 (2001).

Nucleation Phenomenon in Silica Xerogels and Pd/SiO₂, Ag/SiO₂, Cu/SiO₂ catalysts,
Alie, C., Lambert, S., Heinrichs, B., Pirard, R. Pirard, J.-P.,

Abstracts of the 11th International Workshop on Glasses, Ceramics, Hybrids and Nanocomposites from Gels, Albaro Terne (Padova), Italy, September 16-21, Communication P1-121, p.104 (2001).

Gram-scale production of single-wall carbon nanotubes by catalytic decomposition of hydrocarbons,
Bister, G., Niesz, K., Konya, Z., Bossuot, C., Pirard, JP, Colomer JF, Van Tendeloo, G.,
Fonseca, A., Nagy, JB,
Proceedings of the XVth International Winterschool on Electronic Properties of Novel Materials - Euroconference "Molecular Nanostructures, Kirchberg, Austria, March 3-10 (2001).

Image analysis characterization of porous foams,
Blacher, S., Maquet, V., Pirard, J.-P., Jerome R.
Colloids and Surfaces A: Physicochemical and Engineering Aspects, **187-188**, 375-383 (2001).

Non-destructive characterization methods of porous foams,
Blacher, S., Maquet, V., Pirard, R., Jerome, R., Pirard, J.-P.,
Proceedings of the 4th International Symposium on the Effects of Surface Heterogeneity in Adsorption and catalysis on solids, ISSHAC-4, Krakow, Poland, Augustus 27-31, p.175 (2001).

Image analysis characterization of freeze-drying porous materials,
Blacher, S., Maquet, V. Jerome, R., Pirard, J.-P.,
Abstracts of the 8th European Congress for Stereology and Image Analysis, Bordeaux, France, September 4-7, pp.34-35 (2001).

Evaluation of the nanotube length by laser diffraction,
Bossuot, C., Lambert, S., Bister G, Fonseca A., Nagy, JB, Pirard, J.-P.,
Proceedings of the XVth International Winterschool on Electronic Properties of Novel Materials - Euroconference "Molecular Nanostructures, Kirchberg, Austria, March 3-10 (2001).

Mass Transfer in Low-Density cogelled Xerogels,
Heinrichs, B., Pirard, J.-P., Schoebrechts, J.-P.
AIChE Journal, **47**, 1866-1892 (2001).

Method for the Determination of the surface composition of alloy nanocrystallites in bimetallic catalysts,
Heinrichs, B., Lambert, S., Schoebrechts, J.-P. Pirard, J.-P.,
Abstracts of the Fifth European Congress on Catalysis "Europe Cat V"
Limmerich, Ireland, September 2-7, 6-P Communication, 02 (2001).

Study of the nucleation phenomenon and metal dispersion in Pd/SiO₂, Ag/SiO₂ and Ca/SiO₂ sol-gel catalysts,
Lambert, S., Ferauche, F., Heinrichs, B., Pirard, J.-P.,
Abstracts of the Second International Conference on Silica Science and

Technology, Silica 2001, Mulhouse, France, September 3-6, p.126 (2001).

Large scale synthesis of carbon nanotubes and their composite materials,

Nagy JB, Fonseca, A. Pierard, N., Willems, I., Bister, G., Pirlot, C.
Delhalle, J., Mekkalif, Z., Niesz, K. Bossuot, C. Pirard, J.-P., Biro LP,
Konya Z, Colomer JF, Van Tendeloo, G.,

*Proceedings of the XVth International Winterschool on Electronic
Properties of Novel Materials - Euroconference "Molecular
Nanostructures*, Kirchberg, Austria, March 3-10 (2001).

CONTACT:



[Jean-Paul.Pirard @ ulg.ac.be](mailto:Jean-Paul.Pirard@ulg.ac.be)



+ 32 4 366 35 58



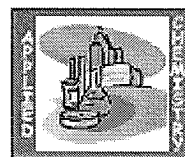
+ 32 4 366 35 45



University



Applied Sciences



Department

Last revised on 30th September 2006 - A. Leonard